

**Predation by the red fox (*Vulpes vulpes*)**



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Red fox (*Vulpes vulpes*) (photo: Bruce Mitchell)

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# NSW Fox Threat Abatement Plan 2010

## Executive Summary

The introduction of the red fox (*Vulpes vulpes*) into Australia in the 1870s has contributed to regional declines and extinctions of a wide range of native fauna, particularly among medium-sized ground-dwelling and semi-arboreal mammals, ground-nesting birds and freshwater turtles. Thus the spread of foxes across southern Australia in the late 1800s and early 1900s coincided with regional extinctions of several species of bettong, the greater bilby, numbat, bridled nailtail wallaby and the quokka. Many of these species persist only on islands or areas of the mainland where foxes are rare or absent. Similarly, foxes have been linked to regional extinctions of four species of ground-nesting birds from western New South Wales and the decline of a further seven such species. More recent experimental studies have shown that foxes continue to suppress populations of several species of rock-wallabies, the eastern grey kangaroo, brush-tailed bettong, long-nosed potoroo, numbat, several species of bandicoots, common brushtail possum, common ringtail possum and the Murray River turtle. Foxes have also caused the failure of numerous attempts to reintroduce threatened native fauna into areas of their former range.

Foxes are now widespread across the continent and eradication is not possible in the immediate future. However, the impacts of foxes on native fauna can be reduced substantially by sustaining intensive broad-area fox control targeting areas where native fauna vulnerable to fox predation persist. The NSW Fox Threat Abatement Plan was initiated in 2001 with the primary objective of establishing long-term across-tenure control programmes in those areas of NSW where impacts on threatened and other native fauna are greatest. Under the plan, fox control has been established at 59 priority sites over almost 1 million ha of public and private lands. Monitoring programmes have been established to measure the responses of target threatened species, other native fauna and foxes to fox control at these sites. Monitoring aims to refine the priorities for control and the methods used over time. Thus a key objective (and successful outcome) of the plan was to ensure available investment in fox control achieved maximum benefits for biodiversity.

This revised NSW Fox Threat Abatement Plan is one of the largest biodiversity conservation programmes in NSW. It mirrors similar efforts in other states, namely the *Western Shield* programme of Western Australia, *Southern Ark* in Eastern Victoria and *Operation Bounceback* in South Australia. The revised plan follows a review of control and monitoring programmes implemented under the plan since 2001. In particular, a small number of changes to priority species and sites are proposed in light of better information on where impacts are and are not likely to be significant. In addition to the primary actions of control and monitoring at priority sites, this plan proposes the development of individual site plans, the centralised collation of data, a mechanism for ongoing review of priority sites, best-practice guidelines for control and monitoring and improved communication.

# NSW Fox Threat Abatement Plan 2010

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## List of Abbreviations

CMA	Catchment Management Authority
DECCW	Department of Environment, Climate Change and Water NSW
LPMA	Land and Property Management Authority (formerly Department of Lands)
FNSW	Forests NSW (now part of Industry and Investment NSW)

## Introduction

The introduction of the red fox (*Vulpes vulpes*) into Australia in the 1870s has had profound and devastating impacts on native fauna. Thus, the spread of foxes across southern Australia has been linked to regional declines and extinctions of a broad suite of medium-sized ground-dwelling mammals, including the brush-tailed bettong (*Bettongia penicillata*), burrowing bettong (*B. lesueur*), Tasmanian bettong (*B. gaimardi*), rufous bettong (*Aepyprymnus rufescens*), greater bilby (*Macrotis lagotis*), numbat (*Myrmecobius fasciatus*), bridled nailtail wallaby (*Onychogalea fraenata*) and the quokka (*Setonix brachyurus*) (Christensen 1980; Schlager 1981; Friend 1990; Southgate 1990; Fisher 1998; Short 1998). Many of these species persist only on islands or areas of the mainland where foxes are rare or absent. Local declines in semi-arboreal mammals, particularly the common brushtail possum (*Trichosurus vulpecula*) and western ringtail possum (*Pseudocheirus oddidentalis*), occurred with the establishment of foxes in south-west Western Australia (Christensen 1980). Predation by foxes and cats has been cited as a major factor in the extinction of four species of ground-nesting birds from western New South Wales and in the decline of a further seven such species (Smith *et al.* 1994).

Fox predation has also contributed to the failure of many attempts to reintroduce native faunas into areas of their former range. In a review of reintroduction programmes for macropods, Short *et al.* (1992) concluded that the failure of many programmes was attributable to the presence of exotic mammalian predators, especially foxes. On islands without exotic predators, 82% (9 of 11) of reintroductions reviewed were successful, compared to only 8% (1 of 13) at mainland or island sites where these predators were present (Short *et al.* 1992). Recent attempts to re-establish macropods and other native mammals at mainland sites have proved more successful with effective predator control. Thus, the control or exclusion of exotic predators has seen successful reintroductions of brush-tailed bettong, burrowing bettong, bridled nailtail wallaby, numbat and golden bandicoot (*Isoodon auratus*) at mainland sites (Christensen & Burrows 1994; Friend & Thomas 1994; Short *et al.* 1994; Fisher 1998; De Tores *et al.* 1998). Similarly, Priddel & Wheeler (1994) cited fox predation as the major cause of death of captive-reared malleefowl (*Leipoa ocellata*), a ground-nesting bird, released into remnant habitat in central NSW. Predation was the proximate cause of death for 94% of birds released (29 of 31), with foxes accounting for up to 65% of birds released (20 of 31). In subsequent experimental releases of malleefowl into areas with and without fox control, Priddel & Wheeler (1997) reported higher survival among birds released into areas under fox control. However, predation by foxes remained the primary source of mortality regardless of treatment.

Where native faunas have persisted despite the establishment of foxes, predator-removal experiments have shown that fox predation remains an ongoing threat to many species. In the Western Australian wheatbelt, replicated removal experiments showed that foxes were suppressing remnant populations of black-footed rock wallaby (*Petrogale lateralis*), thereby increasing the likelihood of local extinction (Kinnear *et al.* 1988, 1998). Populations of rock wallaby increased to 6.4 and 5.0 times their initial densities, respectively, after eight years of fox control at two sites. At sites without fox control, populations increased marginally, decreased or declined to extinction (Kinnear *et al.* 1998). Other experiments (including non-replicated and non-controlled comparisons) have shown that foxes may suppress populations of many other native species including several species of rock wallaby (*Petrogale spp.*), eastern grey kangaroo (*Macropus giganteus*), brush-tailed bettong, long-nosed potoroo (*Potorous tridactylus*), southern brown bandicoot (*Isoodon obesulus*), long-nosed bandicoot (*Perameles nasuta*), common brushtail possum, common ringtail possum (*Pseudocheirus peregrinus*), numbat, and Murray River tortoise (*Emydura macquarii*) (Saunders *et al.* 1995; Friend 1996; Banks *et al.* 2000; Sharp 2000; Spencer and Thompson 2005; Dexter *et al.* 2007; Dexter and Murray 2009). Observations of high mortality among the eggs of ground-nesting birds and freshwater turtles due to fox predation, provide evidence of significant impacts on these species (Frith 1959; Thompson 1983; Wellman *et al.* 2000).

Foxes are now widespread across the continent and eradication is not possible in the immediate future. However, the impacts of foxes on native fauna can be reduced substantially by sustaining frequent broad-area fox control targeting areas where native fauna vulnerable to fox predation persist. Regular aerial baiting of conservation reserves throughout south-west Western Australia under the Western Shield programme has resulted in the recovery of several native species especially the brush-tailed bettong, western quoll (*Dasyurus geoffroyi*) and brushtail possum (Orell 2004). In Victoria, large-scale ground-baiting across forested areas in eastern Gippsland has resulted in increases in long-nosed potoroos (*Potorous tridactylus*), southern brown bandicoots (*Isoodon obesulus*) and brushtail possums (Dexter and Murray 2009).

In New South Wales, frequent, broad-area fox control targeting those native fauna most at risk has been directed by the NSW Fox Threat Abatement Plan (NPWS 2001) since 2001. Under the plan, fox control has been established at 59 priority sites across almost 1 million ha of public and private lands. Monitoring has been established to measure the responses of target threatened species, other native fauna and foxes to fox control at these sites. Monitoring aims to refine the priorities for control and the methods used over time. *Best-practice guidelines for fox control* have also been established, with the objective of identifying control methods that will reduce the impacts of foxes on native fauna in a cost-effective, humane and target specific manner.

This document constitutes the revised NSW Fox Threat Abatement Plan. It reflects an analysis of fox control and monitoring programmes implemented under the plan since 2001. It follows consultation with an array of wildlife managers, public-land managers and other relevant groups including Industry and Investment NSW (incorporating Forests NSW), the Land and Property Management Authority (LPMA), Catchment Management Authorities (CMAs) and the Australian Government Department of the Environment, Water, Heritage and the Arts.

## Legislative Context

Predation by the red fox was the first *key threatening process* listed under the NSW Threatened Species Conservation Act (<http://www.environment.nsw.gov.au/determinations/EuropeanRedFoxKTPListing.htm>). The Act required the former NSW National Parks and Wildlife Service to prepare a *threat abatement plan* which identified the actions needed "to abate, ameliorate or eliminate its adverse effects on threatened species, populations or ecological communities". The NSW Fox Threat Abatement Plan was published in 2001, with the intent that it be reviewed after 5 years.

As a result of changes to the Act in 2004 however, the preparation of threat abatement and recovery plans is now at the discretion of the Director General of the Department of Environment, Climate Change and Water (DECCW). The objective was to rationalise recovery planning via the introduction of the NSW Priorities Action Statement ([http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home\\_PAS\\_new.aspx](http://www.threatenedspecies.environment.nsw.gov.au/tsprofile/home_PAS_new.aspx)). In deciding whether to develop a threat abatement plan for any key threatening process, the Director General may consider:

- the significance of the impact on biodiversity including whether it is the main threat to many species
- whether impact varies with location
- whether there are various abatement strategies in other conservation plans and policy instruments that need to be combined in one document
- whether management of the threat requires coordination and commitment from several public authorities and stakeholders
- whether cost-effective management is available
- whether more effort is needed to coordinate a threat abatement programme and to build on existing initiatives or develop initiatives.

Notwithstanding the need to review the previous plan, predation by the red fox meets most of these criteria. Foxes have had significant impacts on a broad suite of native fauna and they remain the main threat to the survival of many threatened species in NSW. Their impacts vary across species and locations. Cost-effective control is available, but it requires significant and ongoing commitment and coordination across land tenures. Moreover, more effort is needed to build on what has been achieved thus far under the previous plan.

As with the previous plan, actions identified in this plan will be incorporated into other relevant plans and strategies including the NSW Priorities Action Statement, National Parks and Wildlife Service regional pest management strategies (<http://www.environment.nsw.gov.au/pestsweeds/RegionPestManagement.htm>) and the NSW Invasive Species Plan (<http://www.dpi.nsw.gov.au/agriculture/pests-weeds/nsw-invasive-species-plan>). Fox control methods such as toxic baiting, trapping and shooting are subject to various NSW and Australian Government legislation. All control programmes undertaken under this plan will comply with the relevant legislation and associated regulations.

A summary of legislation, regulations, plans and strategies relevant to this plan is provided Appendix 1.

## Priorities for fox control

As a widespread generalist predator, the fox has the potential to prey on all species of native terrestrial vertebrates in NSW. However, the occurrence of a species in the diet of foxes does not imply that mortality due to fox predation is high or that a significant impact on fauna populations exists (Banks 1999). The impacts of fox predation on native fauna appear to be greatest on medium-sized (450-5000g) non-flying mammals, ground-nesting birds and freshwater turtles (Dickman 1996, NPWS 2001). Impacts in temperate environments may be exacerbated by habitat fragmentation caused by the clearing and disturbance of native vegetation (Dickman 1996). Impacts in arid environments may be intensified by the boom-bust cycles in native rodents associated with rainfall (Mahon 1999).

Under the previous plan, a simple model was used to rank the likelihood of impact across all species of native terrestrial vertebrates listed as threatened under the NSW Threatened Species Conservation Act. Thus nine species of mammals, 15 species of birds and eight species of reptiles were ranked as high priority for fox control. A further two species of mammals with intermediate scores were added on the basis that each was restricted to a single site in NSW. Priority sites were identified for each species by considering three site attributes: the probability of impact at the site, the significance of the site to species overall and the ability to achieve effective fox control. Thus a total of 81 priority sites for fox control were identified across NSW (NPWS 2001). Although these sites were selected on the basis of individual threatened species, frequent, broad-area fox control targeting these sites would likely deliver benefits to many other native fauna as well.

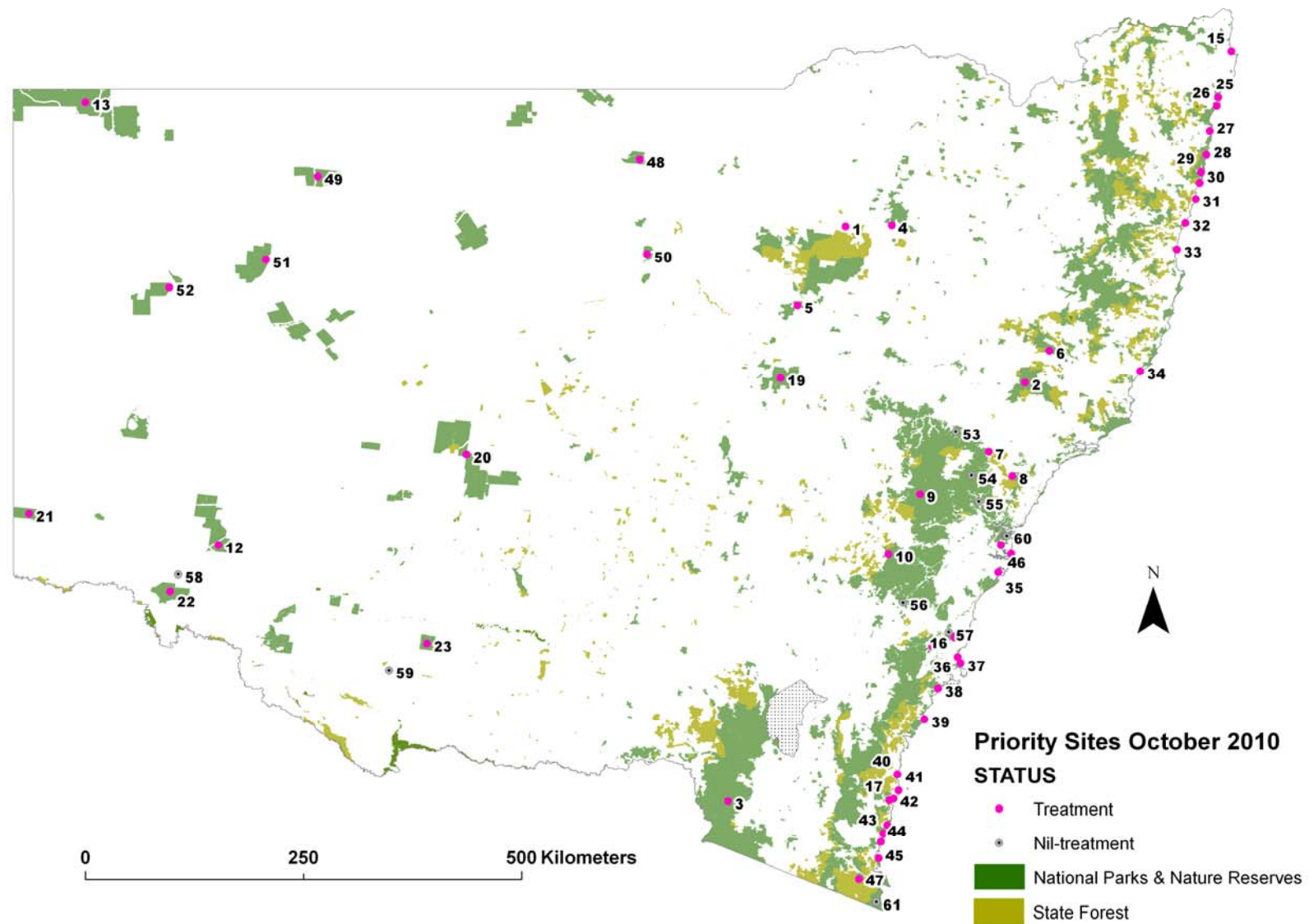
Implementation of the plan since 2001 has seen an ongoing refinement of priorities with the deletion of some sites and the inclusion of others (Mahon 2009). For example, monitoring showed that fox activity at 15 of 16 sites proposed for rufous bettong was low to scarce (cf. Catling and Burt 1995), while there was no evidence of rufous bettong at the 16<sup>th</sup> site. Fox control was established at three sites, but there was no evidence of a response from rufous bettong or other medium-sized mammals from the data available, probably because fox activity at these sites was already low. Work under the plan at all 16 sites has ceased. Other data has resulted in changes to priority sites for the brush-tailed rock wallaby (*Petrogale penicillata*), Albert's lyrebird (*Menura alberti*), malleefowl (*Leipoa ocellata*), plains wanderer (*Pedionomus torquatus*), threatened shorebirds and Bellinger River emydura (*Emydura macquarii*). Detailed analyses of fox control and fauna monitoring data collected since 2001 will be published separately (see Action 7).

In addition to these changes, four sites have been added targeting the long-nosed potoroo. This medium-sized mammal was not ranked as a high priority in the previous plan, given an association with dense understorey vegetation (and hence lower risk). However, the marked response of long-nosed potoroos to broad-area fox control in East Gippsland, Victoria (Dexter and Murray 2009), suggests that this species should be a high priority in NSW.

The revised list of priority sites and the threatened species targeted is given in Table 1 and mapped in Figure 1. The sites are located primarily on national park, state forest and crown land reserves. Private land constitutes a significant proportion of some sites, but it is rarely the major tenure. Note that the model used to identify high priority species in the previous plan was not re-run to consider new listings of threatened species. While the model was a useful starting point, a more refined process for revising priorities for fox control is required (see Revising priorities for control).

The primary action of the plan is for public-land managers (especially the DECCW Parks and Wildlife, Forests NSW and the LPMA) to undertake frequent broad-area fox control at priority sites identified in Table 1. A small number of nil treatment sites have been identified for the purposes of measuring the responses of target threatened species, other native fauna and foxes to fox control against experimental controls (see Monitoring). Public land managers will not undertake fox control at these sites.

Action 1: DECCW, Forests NSW, LPMA and other public-land managers to sustain frequent, broad-area fox control on public lands across priority sites identified in this plan. DECCW to work with private landholders and other relevant groups (e.g. CMAs) to establish fox control on private lands within these sites. Public-land managers are not to undertake fox control at sites identified as nil-treatment. The current list of priority sites and nil-treatment sites is given in Table 1.



**Figure 1.** Priority sites for fox control under the NSW Fox Threat Abatement Plan. Some sites are designated nil-treatment for the purposes of measuring the response of native fauna to fox control.



**Table 1.** Priority sites for fox control under the NSW Fox Threat Abatement Plan. Shown also are the target threatened species and major tenures at each site.

Site No.	Treatment Sites	Threatened Species Targeted	Tenure				
			National Park	State Forest	Crown Land	Dept. Defence	Private
1.	Brigalow Park	Black-striped wallaby	✓				✓
2.	Barrington Tops	Broad-toothed rat	✓				
3.	Snowy Mountains	Broad-toothed rat, mountain pygmy-possum	✓				
4.	Mt Kaputar	Brush-tailed rock wallaby	✓				✓
5.	Warrumbungles	Brush-tailed rock wallaby	✓				✓
6.	Barnard River	Brush-tailed rock wallaby	✓	✓			✓
7.	Broke	Brush-tailed rock wallaby	✓	✓			✓
8.	Watagans	Brush-tailed rock wallaby	✓	✓			✓
9.	Wolgan River	Brush-tailed rock wallaby	✓				✓
10.	Jenolan Caves	Brush-tailed rock wallaby	✓				
11.	Kangaroo Valley	Brush-tailed rock wallaby	✓		✓		✓
12.	Mungo	Chestnut quail thrush, southern scrub robin, western blue-tongued lizard	✓				
13.	Sturt	Long-haired rat, Australian bustard, flock bronzewing, squatter pigeon, centralian blue-tongued lizard, collared whip snake, narrow-banded snake, Stimson's python	✓				
14.	North Head	Long-nosed bandicoot (threatened population), Little penguin (endangered population)	✓			✓	
15.	Tyagarah	Long-nosed potoroo, shorebirds (little tern, pied oystercatcher)	✓				✓
16.	Barren Grounds	Long-nosed potoroo	✓				✓
17.	Gulaga	Long-nosed potoroo	✓	✓			✓
18.	Mimosa Rocks	Long-nosed potoroo, shorebirds (hooded plover, pied oystercatcher)	✓				✓
19.	Goonoo	Malleefowl	✓				
20.	Central Mallee	Malleefowl, chestnut quail thrush, southern scrub robin	✓				
21.	Tarawi	Malleefowl, chestnut quail thrush, southern scrub robin	✓				
22.	Mallee Cliffs	Malleefowl, chestnut quail thrush, southern scrub robin	✓				
23.	Oolambeyan	Plains wanderer	✓				
24.	South Ballina	Shorebirds (pied oystercatcher)	✓		✓		✓
25.	Broadwater Beach	Shorebirds (little tern, pied oystercatcher)	✓		✓		✓
26.	Bombing Range Beach	Shorebirds (pied oystercatcher)	✓			✓	✓
27.	Clarence River Entrance	Shorebirds (beach stone curlew, pied oystercatcher), broilga	✓				✓
28.	Yuraygir Mid	Shorebirds (beach stone-curlew, little tern, pied oystercatcher)	✓				✓
29.	Wolli	Shorebirds (beach stone-curlew, little tern, pied oystercatcher)	✓				✓
30.	Yuraygir South	Shorebirds (beach stone-curlew, little tern, pied oystercatcher)	✓				✓
31.	Hearns Lake	Shorebirds (little tern)	✓				✓
32.	Bongil Bongil	Shorebirds (little tern, pied oystercatcher)	✓				✓

Table 1 continued.

Site No.	Treatment Sites	Threatened Species Targeted	Tenure				
			National Park	State Forest	Crown Land	Dept. Defence	Private
33.	Nambucca Heads	Shorebirds (little tern)			✓		
34.	Manning River	Shorebirds (beach stone-curlew, little tern)	✓		✓		✓
35.	Towra Point	Shorebirds (little tern, pied oystercatcher)	✓				✓
36.	Comerong Island	Shorebirds (pied oystercatcher)	✓		✓		✓
37.	Lake Wollumboola	Shorebirds (little tern)	✓		✓		✓
38.	Conjola	Shorebirds (hooded plover, little tern, pied oystercatcher)	✓				✓
39.	Murramarang	Shorebirds (hooded plover, pied oystercatcher)	✓		✓		✓
40.	Tuross Brou	Shorebirds (little tern, pied oystercatcher)	✓	✓			✓
41.	Narooma	Shorebirds (hooded plover)	✓				✓
42.	Tilba Wallaga	Shorebirds (hooded plover, little tern, pied oystercatcher)	✓		✓		✓
43.	Tathra Beach	Shorebirds (little tern, pied oystercatcher)	✓	✓	✓		✓
44.	Wallagoot Lake	Shorebirds (hooded plover, little tern, pied oystercatcher)	✓				✓
45.	Ben Boyd North	Shorebirds (hooded plover, pied oystercatcher)	✓	✓			✓
46.	Garigal	Southern brown bandicoot	✓		✓		✓
47.	South East Forests	Southern brown bandicoot, long-footed potoroo, long-nosed potoroo, smoky mouse, shorebirds (hooded plover, pied oystercatcher)	✓	✓			✓
48.	Narren Lakes	Terrestrial wetland birds (brolga)	✓				✓
49.	Nocoleche	Terrestrial wetland birds (brolga)	✓				✓
50.	Macquarie Marshes	Terrestrial wetland birds (brolga)	✓				✓
51.	Peery Lake	Terrestrial wetland birds (brolga)	✓				✓
52.	Mutawintji	Yellow-footed rock wallaby	✓				✓
Nil Treatment Sites		Threatened Species Targeted	National Park	State Forest	Crown Land	Dept. Defence	Private
53.	Martindale	Brush-tailed rock wallaby	✓				✓
54.	Big Yango	Brush-tailed rock wallaby	✓				
55.	St Albans	Brush-tailed rock wallaby	✓				✓
56.	Wollondilly	Brush-tailed rock wallaby	✓				✓
57.	Budderoo	Long-nosed potoroo	✓				
58.	Wamberra	Malleefowl					✓
59.	Wanganella	Plains wanderer					✓
60.	Ku-ring-gai	Southern brown bandicoot	✓				✓
61.	Nadgee	Southern brown bandicoot, long-nosed potoroo	✓				

## Monitoring

Monitoring is required to measure the population responses of target threatened species, other native fauna and foxes to fox control at priority sites identified in this plan. Given that the main objective of fox control is to recover threatened species likely to be impacted significantly by fox predation, then these species must be monitored if the success of fox control is to be measured directly. This is important because significant and ongoing resources will be required to maintain fox control at priority sites. If target species fail to respond, monitoring fox populations may help differentiate between inadequate fox control and the lack of significant impacts from fox predation. In particular, other factors may be more important in limiting population growth in target species and thus may be a higher priority for management (Caughley and Gunn 1996). Monitoring the responses of other native fauna serves as a measure of the additional benefits of fox control.

Ideally, measuring the responses of target species to fox control requires monitoring at replicate treatment and nil-treatment sites (Underwood 1997, Quinn and Keough 2002). This presents an array of scientific, management and social challenges, however (Mahon 2009). Some target species cannot be monitored as there are no cost-effective methods available. The small distributions of other species limit the opportunity to establish nil treatment and replicate sites. Furthermore, the effects of rainfall, habitat fragmentation, other exotic species and other management actions may need to be considered in the selection of sites and the analysis of results. Community expectations on land managers for fox control on their land may present challenges in allocating nil-treatment sites.

Given these considerations, the species monitored, methods used and targets for defining success will vary between sites. Further, nil treatment and replicate sites will be available for a limited number of species only. This information will be detailed in site plans (see Site plans).

Action 2: DECCW, Forests NSW, LPMA and other public-land managers to measure the response of target threatened species, other native fauna and/or foxes to fox control at priority sites identified in this plan. The specific objectives and methods of monitoring will be detailed in site plans (Action 3). DECCW to work with private landholders and other relevant groups (e.g. CMAs) to undertake monitoring on private lands as required.

## Site plans

While control methods for foxes have been well documented, the effectiveness of many control programmes in eastern Australia remains limited by variable control effort in time and space and the rapid immigration of foxes from outside control areas (Saunders and McLeod 2007). In the previous plan, best-practise guidelines for fox control were developed with the aim that they would facilitate frequent, broad-area control across priority sites. However, data collected since 2001 shows that fox densities have not been suppressed adequately at many sites, particularly where tenure is complex or access is otherwise limited. There have also been some challenges in the implementation of monitoring programmes, especially with regard to the responsibility for actions and standardisation of data across sites and times.

Site plans will be developed for each of the priority sites with the aim of improving control and monitoring programmes. Site plans will provide specific details on the extent, frequency and methods of fox control proposed for each site. They will describe the objectives and methods of monitoring, including actions at nil-treatment sites where required. They will assign responsibility for all actions and provide a date for review.

Planning at this scale will help public agencies anticipate resource requirements for each site over the short to medium term. Moreover, the review of control and monitoring data against the objectives of the site plans will provide a clear basis for maintaining, refining or ceasing works at any site.

Action 3: DECCW to develop site plans for all priority sites, in consultation with Forests NSW, LPMA, local councils and other relevant groups (e.g. CMAs) as required. Site plans will propose the extent, frequency and methods of fox control required at each site. They will describe the specific objectives and methods of monitoring, including actions at nil-treatment sites where required. They will assign responsibility for all actions and provide a date for review.

## Data recording and management

The capacity to analyse the cost-effectiveness of control programmes and the overall success of the plan is critically dependent on accurate and comprehensive collation of data. This is particularly important because this plan directs significant public resources to address one of the greatest threats to biodiversity in NSW and Australia.

DECCW Parks and Wildlife Group is developing a database for the centralised collation of pest management data, including details of expenditure, control effort and monitoring. It is anticipated that this database will be available to Forests NSW, the LPMA and other key parties to ensure that all relevant data can be collated and analysed across tenure. The database will help resolve inconsistencies in data collection by ensuring the use of standard data sheets. In the short term, fox control and monitoring data may be stored in Feralbase 9.2, while the Atlas of NSW Wildlife has the capacity to store monitoring data for target threatened species and other native fauna.

Action 4: DECCW, Forests NSW, LPMA and other public-land managers to record all fox control on public lands at priority sites in a centralised database maintained by DECCW. The DECCW to work with private landholders and other relevant groups (e.g. CMAs) to record all fox control on private lands at these sites. Arrangements for the storage of monitoring data will be specified in site plans (Action 3).

## Revising priorities for control

Priorities for fox control may need to be revised occasionally when new information becomes available. For example, monitoring conducted under the previous plan found little evidence of fox impacts at 15 of 16 priority sites proposed for rufous bettong and no evidence of rufous bettong at the 16<sup>th</sup> site. Hence these sites could no longer be justified as priorities for fox control. Conversely, new data on the distribution of the brush-tailed rock wallaby and on important nesting locations for threatened shorebirds provided justification for additional priority sites targeting these species.

The previous plan had no defined mechanism for revising priorities beyond the preparation of a new plan. Under this plan, a site may be deleted only after control and monitoring data have been reviewed against the objectives of the site plan. The data may show that impacts at a site are less than expected (as for the rufous bettong sites above), that a site is no longer important for the target species (e.g. threatened shorebirds may shift preferred nesting sites over time) or that effective control can not be achieved at a site despite substantial effort. New sites may be added only after the preparation of a site plan, endorsed by the relevant public-land managers. The site plan must specify the target threatened species and address the three site attributes used to prioritise sites under the previous plan: the potential for impact at a site (fox density and habitat fragmentation), the significance of a site to species overall (higher priority for larger or outlying populations) and the ability to achieve effective fox control (size of area and complexity of land tenure). The target species need not be an existing target species (as per Table 1), but evidence of the likelihood of population-level impacts from fox predation must be provided.

Treatment and nil-treatment sites may be switched to improve measurement of the response of target threatened species to fox control. Nil-treatment sites may become treatment sites where fox control has delivered a significant and measurable recovery of target species at treatment sites and resources are available to expand works into nil-treatment areas. Again, the review of control and monitoring data will underpin these changes.

Revisions will be published by DECCW on the internet (see Communication).

Action 5: DECCW to revise lists of priority species and sites as required during the life of the plan. Revisions will be published on the internet (Action 7).

## **Best-practice guidelines for control and monitoring**

*Interim best-practice guidelines for fox control* were established under the previous plan with the objective of identifying control methods that would reduce the impacts of foxes on native fauna in a cost-effective, humane and target specific manner. These guidelines require updating. Updated guidelines will not only inform the development of Site Plans, but they may be useful for a broader audience and application. The guidelines will be extended to address monitoring so that information on the methods used at priority sites is widely available.

The existing guidelines were called interim in the previous plan because research seeking to quantify the non-target risks associated with certain forms of 1080 baiting was in progress. Much of this work has since been published (Körtner *et al.* 2003, Körtner and Watson 2005, Claridge and Mills 2007) with important implications for control programmes. The updated guidelines will reflect the findings of this research.

Action 6: DECCW to publish best-practice guidelines for fox control and monitoring and update as required (Action 7).

## **Communication**

Significant resources have been directed into fox control and fauna monitoring under the previous plan since 2001. It is a complex and diverse programme involving many participants. A review of the previous plan highlighted the need for better communication between the participants. DECCW also continues to receive public enquiries regarding efforts to address the impacts of foxes on biodiversity in NSW. Greater efforts are thus needed to communicate information relating to the implementation of this plan, including priorities for fox control, details of control programmes and the responses of target threatened species, other native fauna and foxes. A DECCW webpage will be developed to provide better information to stakeholders (including public agencies, private landholders and scientific community) and the general public.

Action 7: DECCW to publish information relating to the implementation of this plan on the internet.

## **Implementation**

Implementation of this plan will be coordinated by the DECCW Pest Management Unit.

## **Estimated Costs**

The estimated cost of implementing this plan across all land tenures in the first year is about \$2.4 million. This cost is partitioned by agency and action in Table 2. Estimates are based on expenditure on existing programmes where appropriate. Most of the costs are in-kind (i.e. existing staff and vehicles); staff costs were calculated at \$100,000 per person per year (including on-costs) while vehicle costs were calculated at \$62/day. The development of site plans will provide more accurate estimates of ongoing costs by site. Thus, the figures given in Table 2 are interim estimates only. Costs are subject to inflation and may vary in future years depending on reviews of priority species and sites.

The costs of implementation in the first year by agency are \$1.983 million, \$80,000 and \$75,000 for DECCW, Forests NSW and LPMA respectively. The majority of these costs are for fox control and monitoring on public lands at priority sites. An additional \$270,000 per annum is estimated for fox control on private lands and \$5000 per annum for fox control on lands managed by the Department of Defence. Funding for these works was provided previously by the Australian Government (Natural Heritage Trust), CMAs and the Department of Defence. Future funds from these sources are not guaranteed.

Actions 3 to 7 will be implemented largely by DECCW. The cost of Action 3 was estimated on the assumption of preparing 24 plans in the first year at two weeks staff-time per plan. This is equivalent to one full time position. This cost will decline in subsequent years as more plans are prepared, but there will be an ongoing cost for periodic review. The cost of Action 4 was based on the estimated effort required to collate

and enter data into a centralised database and for the maintenance of that database; it does not include the cost of establishing the database. The cost was estimated as 0.5 of a full time position. The costs of Action 5 and 6 consider the time required for data analyses, literature review and liaison with relevant parties. These costs were estimated as 0.125 of a full time position per action. The cost of communication considers the time required to prepare material for publication; this was estimated as 0.125 of a full time position. Forests NSW and the LPMA would each need to contribute approximately 0.1 full time positions to supporting Actions 3 to 7 each year.

**Table 2.** Total estimated cost of implementation of this plan in year 1.

Action	Description	Agency	Cost (\$,000)
1	Fox control	DECCW	950
		FNSW	40
		LPMA	65
		Other tenure	275
	<b>Fox Control Total</b>		<b>1330</b>
2	Monitoring	DECCW	845
		FNSW	30
	<b>Monitoring Total</b>		<b>875</b>
3	<b>Site Plans Total</b>	DECCW	<b>100</b>
4	<b>Data Recording and Management Total</b>	DECCW	<b>50</b>
5	<b>Revising Priorities Total</b>	DECCW	<b>12.5</b>
6	<b>Best-practice Guidelines Total</b>	DECCW	<b>12.5</b>
7	<b>Communication Total</b>	DECCW	<b>12.5</b>
3-7		FNSW	<b>10</b>
		LPMA	<b>10</b>
<b>Estimated cost of plan in year 1</b>			<b>2,413</b>

### Date for Review

Ten years from the date of publication of this plan.

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## Appendix 1: NSW and Australian Government legislation, strategies and plans relevant to the NSW Fox Threat Abatement Plan

National / State	Strategy / Act	Relevance to this plan	Strategy / Act URL
NSW	<i>Threatened Species Conservation Act 1995 (TSC Act)</i>	<ul style="list-style-type: none"> <li>• <i>Predation by the red fox</i> was listed as a key threatening process under this Act in March 1998.</li> <li>• This plan has been prepared in response to the listed threat with the objective to “abate, ameliorate or eliminate its adverse effects on threatened species, populations or ecological communities”.</li> <li>• All actions in this plan are included in the NSW Threatened Species Priorities Action Statement (PAS).</li> </ul>	<a href="http://www.legislation.nsw.gov.au/viewto p/inforce/act+101+1995+fn+0+N">http://www.legislation.nsw.gov.au/viewto p/inforce/act+101+1995+fn+0+N</a>
NSW	<i>NSW National Parks and Wildlife Act 1974</i>	<ul style="list-style-type: none"> <li>• Under this Act a Plan of Management is required for each reserve managed by NPWS.</li> <li>• Plans of Management identify key pest species present, but the management actions to address these pests are identified in Regional Pest Management Strategies, including any actions outlined in the PAS.</li> <li>• The objectives of this plan have been incorporated into the Regional Pest Management Strategies.</li> </ul>	<a href="http://www.legislation.nsw.gov.au/viewto p/inforce/act+80+1974+FIRST+0+N">http://www.legislation.nsw.gov.au/viewto p/inforce/act+80+1974+FIRST+0+N</a>
NSW	NSW Invasive Species Plan	<ul style="list-style-type: none"> <li>• This is the overarching plan for management of invasive species in NSW, including management for conservation objectives.</li> <li>• The plan articulates three goals for invasive species management: prevention of the establishment of new invasive species; elimination or prevention of the spread of new invasive species; and reduction of the impacts of widespread invasive species.</li> <li>• This plan is an example of how widespread invasive species are managed to reduce impacts on wildlife.</li> </ul>	<a href="http://www.dpi.nsw.gov.au/agriculture/pe sts-weeds/nsw-invasive-species-plan">http://www.dpi.nsw.gov.au/agriculture/pe sts-weeds/nsw-invasive-species-plan</a>

National / State	Strategy / Act	Relevance to this plan	Strategy / Act URL
NSW	<i>Pesticides Act 1999</i> (Pesticide Control Order under Section 38)	<ul style="list-style-type: none"> <li>Schedule 2 of the “Pesticide Control Order under Section 38” of this Act governs how the storage, preparation, transport and application of 1080 must be carried out for fox control in NSW.</li> <li>The Act therefore strongly influences site planning, training, management and operations within programmes for this plan.</li> </ul>	<p><i>Pesticides Act 1999:</i></p> <p><a href="http://www.legislation.nsw.gov.au/maintop/view/inforce/act+80+1999+cd+0+N">http://www.legislation.nsw.gov.au/maintop/view/inforce/act+80+1999+cd+0+N</a></p> <p>Pesticide Control Order under Section 38 of the <i>Pesticides Act 1999:</i></p> <p><a href="http://www.environment.nsw.gov.au/resources/pesticides/2008lcbait1080.pdf">http://www.environment.nsw.gov.au/resources/pesticides/2008lcbait1080.pdf</a></p>
NSW	<i>Environmental Planning and Assessment Act 1979</i>	<ul style="list-style-type: none"> <li>Under this Act, applications of pesticides are not classed as ‘activities’ (unless the pesticide involves the construction of a permanent structure), therefore their use does not require a Review of Environmental Factors (REF).</li> <li>NPWS undertake Conservation Risk Assessments (CRAs) for fox control works on-park in accordance with Parks and Wildlife policy, but CRAs are not a legislative requirement.</li> </ul>	<p><a href="http://www.legislation.nsw.gov.au/maintop/view/inforce/act+203+1979+cd+0+N">http://www.legislation.nsw.gov.au/maintop/view/inforce/act+203+1979+cd+0+N</a></p>
NSW	<i>Rural Lands Protection Act 1998</i>	<ul style="list-style-type: none"> <li>This Act allows the Minister for Primary Industries to make orders declaring certain animals as pests, which in turn requires all occupiers of the land to control the pest.</li> <li>There is currently no ‘pest control order’ for foxes, and therefore fox control is not mandatory according to this Act.</li> </ul>	<p><a href="http://www.legislation.nsw.gov.au/maintop/view/inforce/act+143+1998+cd+0+N">http://www.legislation.nsw.gov.au/maintop/view/inforce/act+143+1998+cd+0+N</a></p>

National / State	Strategy / Act	Relevance to this plan	Strategy / Act URL
NSW	<i>Forestry and National Parks Estate Act 1998</i>	<ul style="list-style-type: none"> <li>• Under the Terms of the Threatened Species Licenses (TSLs), within the Integrated Forestry Operations Approval (IFOA), Forests NSW were required to prepare a Feral and Introduced Predator Plan (FIPA) to mitigate the potential impacts of foxes on native species following harvesting operations.</li> <li>• The FIPA was prepared in 2002 and subsequently a series of Regional Pest Animal Management Plans (RPAMP) have been prepared by Forests NSW under the Ecologically Sustainable Forest Management (ESFM) requirements of the IFOA.</li> <li>• RPAMPs acknowledge the requirements of this plan and are integrated with actions of this plan where appropriate.</li> </ul>	<a href="http://www.legislation.nsw.gov.au/maintop/view/inforce/act+163+1998+cd+0+N">http://www.legislation.nsw.gov.au/maintop/view/inforce/act+163+1998+cd+0+N</a>
NSW	<i>Local Govt Act 1993</i>	<ul style="list-style-type: none"> <li>• This Act outlines the requirement for local councils to adopt practices of management which are consistent with threat abatement plan objectives, where council land is identified for involvement in a threat abatement plan.</li> </ul>	<a href="http://www.legislation.nsw.gov.au/maintop/view/inforce/act+30+1993+cd+0+N">http://www.legislation.nsw.gov.au/maintop/view/inforce/act+30+1993+cd+0+N</a>
National	<i>Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)</i>	<ul style="list-style-type: none"> <li>• Predation by the European red fox is listed as a key threatening process under this Act. The threat abatement plan for predation by the European red fox (National Fox Threat Abatement Plan) was prepared in accordance with the requirements of the Act.</li> <li>• The approach to fox control for biodiversity protection in this NSW plan is broadly consistent with the principles outlined in the National Fox Threat Abatement Plan.</li> </ul>	<a href="http://www.environment.gov.au/epbc/index.html">http://www.environment.gov.au/epbc/index.html</a>